Faculty of Electronic and Computer Engineering

DESIGN OF WIDEBAND MICROWAVE BANDPASS FILTER WITH NOTCH CHARACTERISTIC USING DEFECTED STRUCTURE

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DECLARATION

I declare that this thesis entitled “Design of Wideband Microwave Bandpass Filter With Notch Characteristic Using Defected Structure” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Electronic Engineering.

Signature : .....

Supervisor Name : .....

Date : .....

ABSTRACT

Bandpass filter is an essential component, in microwave wireless communication systems, which is typically used in both receivers and transmitters. Bandpass filter with wideband passband has been attracting a lot of interests of researcher to employing different methods and techniques. However, some existing radio systems that use narrow band signals, such as IEEE 802.11a WLAN in the band 5.2 GHz, can cause an interference with the wideband systems (3-6 GHz). Therefore, this thesis presents new techniques for the design of microwave bandpass filter at 3-6 GHz which cover wideband with fractional bandwidth of about 66.67%. The return loss is better than 16 dB and insertion loss is less than 0.9 dB. This filter was constructed by using short circuit stubs bandpass filter for microstrip structure and generalized Chebyshev bandpass filter for suspended stripline structure. The suspended stripline structure bandpass filter used the method of cascading generalized Chebyshev low-pass and high-pass filters. This technique provides various advantages such as reducing the number of elements and transmission zeros can be placed in arbitrary frequency response. In order to avoid the interference from existing system that operates in the frequency band, a defected structure was introduced to generate a narrow notch band. Then the defected structure with inverse T-shape will be integrated with the band-pass filter in order to provide high attenuation is 21 dB with narrow bandwidth of 5.83% and *Q*-factor of about 34.33. The second design is defected stripline structure with J-shape that integrated with a generalized Chebyshev bandpass filter. The notch response of measured value is 5.2 GHz at 25 dB resonant frequencies with fractional bandwidth of 6.79% and *Q*-factor is about 34.78. By integrating this defected structure, the overall size can be reduced about 15% and it provides easy technique to produce band reject response. This structure is very useful for wireless systems as it can be easily integrated with other planar devices. Advanced Design System (ADS) software was used to simulate the design from circuit element to physical momentum realization. The experimental results showed good agreement with the simulated results. The benefits of the integrated band-pass filter and defected structure are the reduction of the overall size, easier to fabricate and high *Q*-factor. This new design of microwave filter is considered suitable and an alternative solution for wireless and radar application without any addition of external components in the cascaded structure.

ABSTRAK

Penapis laluan lulus merupakan komponen penting di dalam sistem komunikasi tanpa wayar gelombang mikro yang biasanya digunakan pada kedua-dua penerima dan pemancar. Penapis laluan lulus dengan jalur lebar telah menarik minat ramai penyelidik untuk mengkaji dengan menggunakan kaedah dan teknik yang berbeza. Walaubagaimanapun, terdapat beberapa sistem radio yang menggunakan jalur isyarat yang kecil, seperti IEEE 802.11a WLAN iaitu di dalam jalur 5.2 GHz dan boleh menyebabkan gangguan terhadap jalur lebar (3-6 GHz). Oleh itu, tesis ini membentangkan teknik-teknik baru dalam mereka bentuk gelombang mikro penapis laluan lulus pada frekuensi 3-6 GHz yang mana meliputi jalur lebar dengan pecahan jalur lebar kira-kira 66.67%. Pekali pantulan adalah lebih baik daripada 16 dB dan pekali penghantaran adalah kurang daripada 0.9 dB. Penapis ini telah dibina dengan menggunakan short circuit stubs laluan lulus untuk struktur mikrojalur dan Chebyshev umum penapis laluan lulus untuk struktur stripline tergantung. Bagi struktur stripline tergantung, penapis laluan lulus dihasilkan dengan menggunakan kaedah gabungan Chebyshev umum laluan rendah dan laluan tinggi. Dengan menggunakan teknik ini, pelbagai kelebihan yang diperolehi antaranya dapat mengurangkan bilangan komponen dan transmission zeros boleh dibawa ke mana-mana frekuensi yang dikehendaki. Untuk mengelakkan gangguan dari sistem yang beroperasi dalam jalur frekuensi yang sedia ada, struktur hakisan telah diperkenalkan untuk menghasilkan tindak-balas notch. Kemudian, struktur hakisan berbentuk songsangan T akan disepadukan dengan penapis laluan lulus supaya dapat menyediakan kelemahan yang tinggi sebanyak 21 dB yang mempunyai tindakbalas notch sebanyak 5.83% dan faktor Q kira-kira 34.33. Reka bentuk kedua ialah struktur hakisan stripline dengan berbentuk J yang disepadukan dengan Chebyshev umum penapis laluan lulus. Tindak-balas notch yang diukur ialah 5.2 GHz pada 25 dB resonant frekuensi dengan pecahan lebar jalur adalah 6.79% dan faktor Q adalah kira-kira 34.78. Dengan menyepadukan struktur hakisan ini, keseluruhan saiz dapat dikurangkan kira-kira 15% dan menghasilkan teknik yang mudah untuk mengasingkan frekuensi yang tidak diingini. Struktur ini sangat berguna untuk sistem tanpa wayar kerana ia mudah untuk digabungkan dengan peranti satah yang lain. Perisian yang digunakan untuk simulasi ialah Advanced Design System (ADS) yang dimulakan dengan mereka bentuk elemen litar dan direalisasikan kepada bentuk momentum fizikal. Keputusan eksperimen yang ditunjukkan adalah sama dengan hasil simulasi. Kelebihan penapis laluan lulus bersepadu dan struktur hakisan adalah; pengurangan saiz keseluruhan, lebih mudah untuk direka bentuk dan faktor Q yang tinggi. Struktur baru penapis gelombang mikro dianggap sesuai dan penyelesaian alternatif kepada sambungan tanpa wayar dan aplikasi radar tanpa menggunakan penambahan komponen luaran untuk struktur tersebut.

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LIST OF ABBREVIATION

CNC - Computer Numerical Control

DGS - Defected Ground Structure

DMS - Defected Microstrip Structure

DSS - Defected Stripline Structure

EM - Electromagnetic

EBG - Electromagnetic Band Gap

PBG - Photonic Band Gap

RF - Radio Frequency

RX - Recieve

SAW - Surface Acoustic Wave

SIW - Substrate Integrated Waveguide

SSS - Suspended Stripline Structure

TEM - Transverse Electromagnetic

TX - Transmit

UWB - Ultra-Wideband

VNA - Vector Network Analyzer

WLAN - Wireless Local Area Network